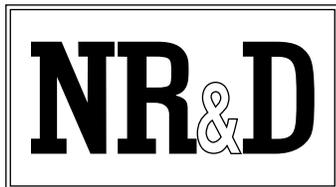


MUCM Modbus/SmartBob

Installation and Programming Manual

This Manual describes the MUCM application for interfacing BinMaster SmartBobs to a Modbus serial network.

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Introduction

The Niobrara MUCM is a Modicon Momentum[®] compatible module that is capable of running multiple applications for performing communication translations between serial protocols. This document covers an application that allows Modbus serial masters to gather data from BinMaster SmartBob SBR II level measurement sensing units.

Support is provided for a multidrop RS-485 network of up to 32 SmartBobs. The data from each bob is presented as Modbus Holding Registers (4x). Each bob is assigned a unique Modbus slave address. A special Modbus slave address of 247 is provided to give a summary of all of the depth measurements from all bobs. New measurements may be commanded by writing a value to the individual slave or to the special summary slave. The MUCM may be configured as a Modbus RTU (default) or Modbus ASCII slave. The baud rate (default=9600), data bits (default=8), and parity (default=EVEN) may all be configured through a built-in terminal server on the RS-232 port.

This MUCM application supports a communications tophat where the data from the first 28 bobs are given. If a normal tophat is not used, it is advisable to cover the opening where a tophat would normally connect to protect the exposed circuit board. NR&D part number METH-001 is an inexpensive empty tophat case sold for this purpose.

Only one of the two application areas are used for this data concentrator application: appl.qcm is compiled and loaded into application area 1 of the MUCM.

Port 1 of the MUCM is RS-232 and is to be connected to the Modbus Master. The Niobrara MU1 cable is usually used for the connection to the 9-pin RS-232 port on a PC. Port 2 of the MUCM is RS-485 and is to be connected to the SmartBob network.

The MUCM contains its own power supply and needs a source of 9 to 30 Volts, AC or DC. An ideal 12VAC transformer is available from NR&D as part number TR121-ST.

Installation

Installation of the MUCM should go quickly, with the necessary materials. The following items are necessary:

- MUCM
- MU1 cable (or equivalent can be built; see Figure 2-1)
- Power source for MUCM (use NR&D part TR121-ST or available power)
- Cabling between MUCM and Modbus Master may be built or purchased
- Cabling between MUCM and SmartBob equipment may be built or purchased. All mating connectors are supplied with MUCM; network cabling is not provided.
- PC with terminal emulator, or terminal with RS-232 port.

The following may be used:

- DIN rail for mounting
- Empty Momentum tophat plastic to close MUCM case (NR&D part METH-001)

Module Installation

- 1 Mount the MUCM on a DIN rail, or mount as desired using screws through the two holes provided. The DIN rail or mounting screws should be Earth-grounded for the MUCM serial ports' transient suppression.
- 2 Supply power to the MUCM; NR&D's TR121-ST may be used, or any available power source 9-30 Volts AC or DC.

Software Installation

The application files for the MUCM are included in the MUCM_SMARTBOB_SETUP.EXE file. The latest version of this file is located at <http://www.niobrara.com>

Follow the link for "Application Notes", select "MUCM", and "SmartBob".

Serial Connections to the MUCM

Port 1 to Modbus Master

Port 1 of the MUCM is RS-232 so a simple 3-wire cable is required to connect to the master device. In general, the master's Tx signal will connect to the MUCM's Rx, and the master's Rx signal will connect to the MUCM's Tx. Signal ground must run from the master to the MUCM, and each device will have its RTS and CTS handshaking pins shorted together.

The Niobrara MU1 cable may be used if the mast has a standard PC-style 9-pin RS-232 serial port. For other standard connections, see the MUCM manual, or contact NR&D's technical support.

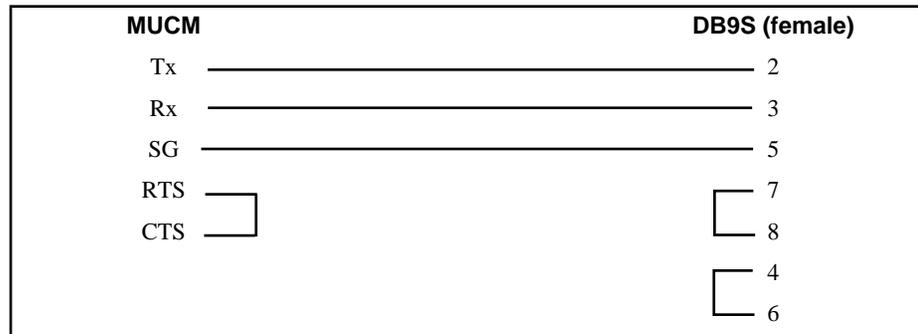


Figure 2-1 MUCM to PC RS-232 (MU1 Cable)

Port 2 to SmartBob Network

Port 2 of the MUCM is RS-485 so a simple 2-wire cable is required to connect to the SmartBob devices. Twisted pair cable should be used.

2-wire RS-485 slaves are supported by the MUCM by jumpering the TX+ and RX+ together to make the (+) connection and the TX- and RX- together for the (-) connection.

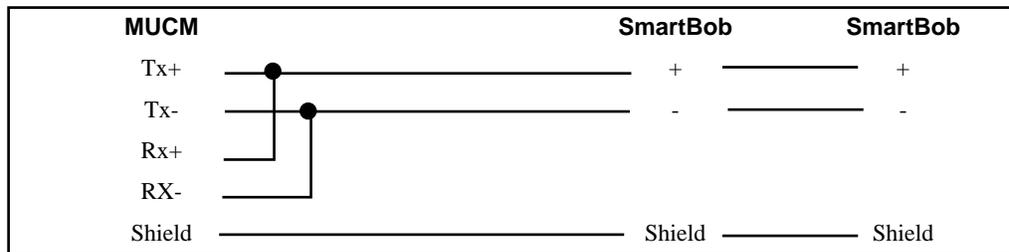


Figure 2-2 MUCM to 2-wire Modbus Slaves

A physical connection must be made from the personal computer to the MUCM in order to download the applications. This link is a serial connection from a COM port on the personal computer to the RS-232 port on the MUCM. The Niobrara MU1 cable may be used for this connection. This cable is shown in Figure 2-1.

Loading the Applications into the MUCM

The MUCM is rapidly evolving so be sure to upgrade the firmware in the module before loading the latest version of APP1.QCC. Most likely the QCOMPILE.EXE has been updated so be sure to use the newest version. The MUCM-001 and MUCM-002 use different firmware files: MUCM1.FWL (or MUCM1.QCC) is for the MUCM-001; MUCM.FWL (or MUCM.QCC) is for the MUCM-002. Firmware upload is as follows:

FWLOAD MUCM Firmware Update.

If the MUCM has corrupt firmware or completely non-responsive then the old method of using FWLOAD may be required.

Firmware upload is as follows:

- 1 Move the yellow RUN/LOAD switch near the power connector to LOAD.
- 2 Only the 3 light should be on.
- 3 Connect the PC to QUCM Port 1 with a MU1 cable.
- 4 Locate the and start the program FWLOAD.EXE. This program may be accessed by "Start, Programs, Niobrara, MUCM, Fwload MUCM Firmware".
- 5 If the above start menu link was followed, the proper MUCM.FWL file will be loaded. Otherwise, click on the Browse button and select c:\Niobrara\Firmware\mucm.fwl for an MUCM-002 or c:\Niobrara\Firmware\mucm1.fwl for an MUCM-001.
- 6 Select the PC's serial port (COM1).
- 7 Press START to begin the download process. If difficulty is experienced in completing the download, try marking the Slow box and pressing start again.
- 8 When the download is completed, move the yellow LOAD/RUN switch back to RUN.



Figure 2-3 FWLOAD

QLOAD APP1

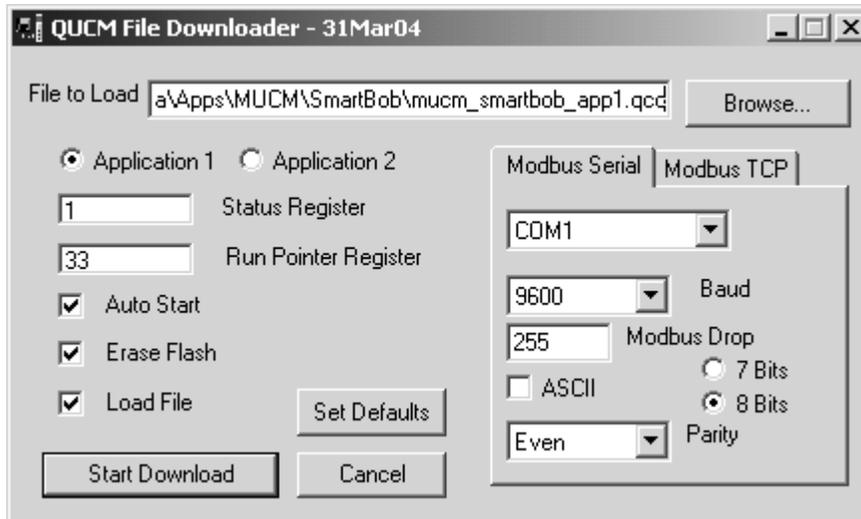


Figure 2-4 QLOAD of APP1

- 1 Application Switch 1 (left) must be in HALT.
- 2 Start QLOAD.EXE The Start Menu link is "Start, Programs, Niobrara, MUCM, Apps, SmartBob, QLOAD SmartBob Application 1".
- 3 Click on the Browse button and select the file MUCM_SMARTBOB_APP1.QCC.
- 4 Select the Application 1 Radio Button.
- 5 Verify the following:
 - a. Status Register = 1.
 - b. Run Pointer Register = 33.
 - c. Auto Start is checked.
 - d. Erase Flash is checked.
 - e. Load File is checked.
 - f. The Modbus Serial tab is selected.
 - (1) The PC's com port is selected (COM1).
 - (2) The baud rate is set for 9600.
 - (3) The Modbus Drop is set to 255.
 - (4) The ASCII button is **NOT** checked.
 - (5) The 8 bits button is selected.
 - (6) The parity is set for EVEN.
- 6 Press the Start Download button. QLOAD will open a progress window to show the status of the download.
- 7 After downloading the application, Move Switch 1 to RUN. The RN1 light should be on.

Table 2-1 MUCM Port Default Settings

Setting	Port 1 Value	Port 2 Value
Protocol Mode	Modbus RTU	SmartBob
Baud Rate	9600	2400
Parity	EVEN	NONE
Data Bits	8	8
Stop Bits	1	1

The MUCM uses a look-up table to determine which bobs to poll and the Modbus Slave address to associate with a given bob. The MUCM will answer Modbus RTU requests on its RS-232 port that are directed to a valid Modbus Slave Address only if it can communicate with the bob. If the MUCM is not able to communicate with the bob then it will not respond to queries to the slave address.

The MUCM will respond to queries directed to two special Modbus slave addresses of 247 and 255, even if it cannot communicate with the bobs. These special addresses allow modification of the MUCM port parameters for trouble-shooting.

Terminal Setup

The setup parameters may be inspected and modified by connecting a terminal or emulator such as Hyperterminal to MUCM port 1 with an MU1 cable.

- 1 Connect the PC to the MUCM port 1 with the MU1 cable.
- 2 Move switch 2 to MEM PROT on the MUCM. All four user lights will come on briefly with lights 1 and 3 on and possibly 2.
- 3 Start Hyperterminal. This program is usually in Start, Programs, Accessories, Communications, Hyperterminal. Make sure the connection is for the proper COM port at 9600, N, 8, 1 and VT100 emulation.

Pressing ESC or Enter on the keyboard should bring up a screen as shown in Figure 2-5. Pressing the "P" key will allow the Modbus port to be edited. Each entry to edit is adjusted by pressing the space bar or + and - keys. When the correct entry is selected then press the Enter key. Pressing the ESC will back out without changing the parameter. Pressing the "W" key will write the setup to FLASH. The keys are not case sensitive.

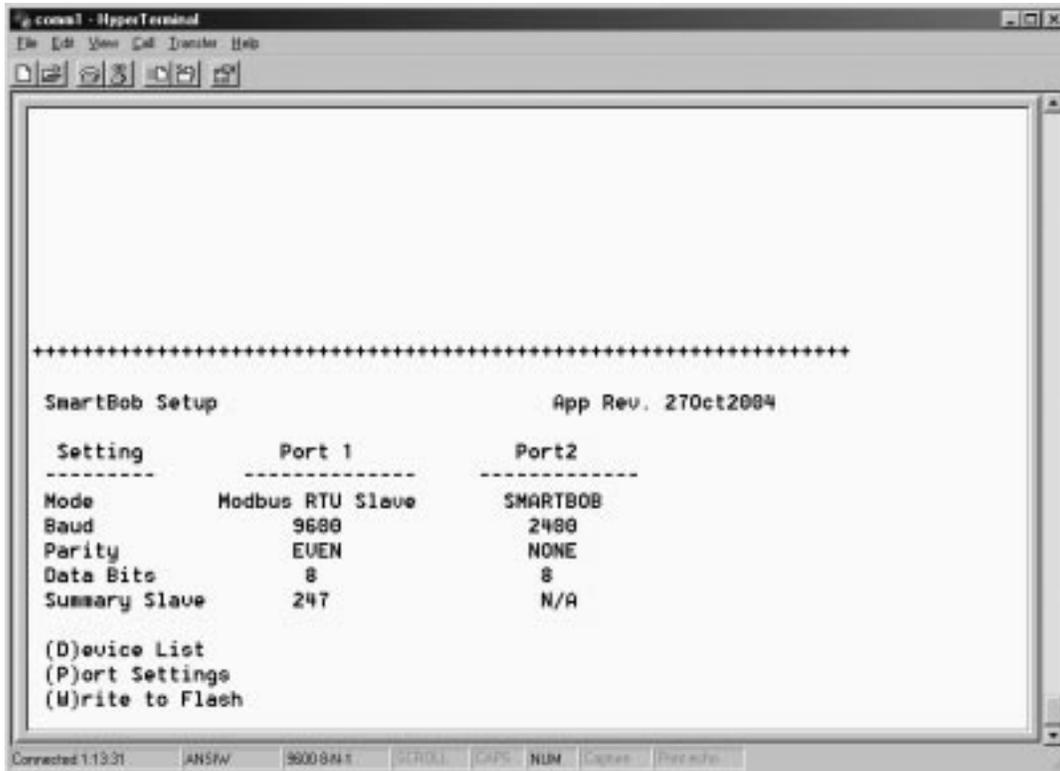


Figure 2-5 Hyperterminal Setup Main Screen

The following entries may be edited for the Modbus RS-232 port:

- Mode - The default is Modbus RTU Slave. The MUCM also support Modbus ASII Slave.
- Baud Rate - The default baud rate is 9600. The options are 2400, 4800, 9600, and 19200.
- Parity - The default value is EVEN with the option for NONE.
- Data Bits - The default value is 8. The value 7 may be selected only in Modbus ASCII mode.
- Summary Slave - This is the Modbus Slave address for the summary table of all attached bobs. This value defaluts to 247. Possible settings are 240 though 250.



Figure 2-6 Hyperterminal Setup Device Screen

The Modbus Routing Table is accessed by pressing the "d" key for device list.

Press the "a" key to add a new device. There will be prompts for the Modbus Slave address and SmartBob slave address. Use the space bar or + or - keys to change numbers and press Enter to accept a new value.

Press the "e" key to edit a particular entry. Use the space bar to choose the entry to edit and then Enter key to accept the entry.

Press the "r" key to remove an entry.

Press the Esc key to return to the main menu.

NOTE: When finished, press the "w" key to write the new settings to flash. Otherwise the new settings will be lost on the next power cycle of the MUCM.

Modbus Operation

The SmartBob MUCM application uses Port 1 for Modbus communication. By default, Port 2 is set for Modbus RTU Slave, 9600 baud, 8 data bits, EVEN parity

SmartBob Device Register List

The data from a given SmartBob is presented as Holding Registers (4x). Register 1 is Read/Write and any value written to this register will cause the bob to take a new reading. Registers 2 through 66 are read only 16-bit unsigned integers that provide data on the bob. Several data points have an implied decimal place to give a greater precision for the reading. For example, register 6 indicates the depth of the product in feet times 10. A value of 599 indicates a depth of 59.9ft.

Table 3-1 SmartBob Register List

Register	Measurement	Notes
4x0001	Acquire New Reading	Write any value to this register to trigger a new reading.
4x0002	MUCM Port Number	Always 1 for RS-485 port
4x0003	SmartBob Slave Address	0-130
4x0004	Device Type	0=SmartBob
4x0005	Measurement Status	See Table 3-2
4x0006	Depth in feet	times 10 (123 = 12.3ft)
4x0007	Pulse Count	
4x0008	Reading Age in Minutes	0-65535
4x0009	Vessel ID	0-255
4x0010	Vessel Shape	ASCII "R"=Rectangle, "C"=Cylinder
4x0011	Vessel Height in feet	times 10
4x0012	Vessel Width in feet	times 10
4x0013	Vessel Length in feet	times 10
4x0014	Vessel Diameter in feet	times 10
4x0015	Volume Offset	cubic feet
4x0016	Density whole	
4x0017	Density fraction in .0001	
4x0018	Dimension Unit	0=ft, 1=yards, 2=meters
4x0019	Weight Unit	0=pounds, 1=kg, 2=tons, 3=metric tons, 4=slugs
4x0020	Volume Unit	0=cu ft, 1=cu yd, 2=gallons(dry), 3=gallons(liquid), 4=bushels, 5=cu meters, 6=liters, 7=barrels(dry), 8=barrels(oil), 9=barrels(liquid)
4x0021	Density Unit	0=pounds/cu ft., 1=pounds/cu yd, 2=pounds/gallon, 3=kg/cu meter, 4=kg/liter
4x0022	High Alarm Level in feet	times 10
4x0023	Low Alarm Level in feet	times 10

Table 3-2 Measurement Status List

Status Value	Meaning
0	Retracted
1	Started Descending
2	Descending
3	Retracting (High Torque)
4	Retracting (Low Torque)
5	Manual Retracting (High Torque)
6	Manual Retracting (Low Torque)
7	Manual Cycle Started Descending
8	Manual Cycle Descending
9	Manual Cycle Retracting (High Torque)
10	Manual Cycle Retracting (Low Torque)
11	Retry Retract (High Torque)
12	Retry Retract (Low Torque)
13	Retract Failed
14	Manual Cycle Retract Failed
15	Bob Stuck At Top
16	Bob Stuck At Bottom
17	Motor Fault
100	Measurement Pending
101	Measurement Pending

Table 3-3 Address 247 Summary Register List

Register	Measurement	Notes
4x0001	Acquire All New Measurements	Write the Modbus slave address of a single bob to trigger a drop. Write any value ≥ 240 to drop on all bobs.
4x0002	Online Status (dev 1-16) Bit 0 = bob 1, bit 15 = bob 16	Each bit represents a SmartBob. If the bit is on then the bob is online.
4x0003	Online Status (dev 17-32) Bit 0 = bob 1,7 bit 15 = bob 32	Each bit represents a SmartBob. If the bit is on then the bob is online.
4x0004, 4x0005	Reserved	
4x0006	Valid Data Status (dev 1-16) Bit 0 = bob 1, bit 15 = bob 16	Each bit represents a SmartBob. If the bit is on then the depth data is valid.
4x0007	Valid Data Status (dev 17-32) Bit 0 = bob 1,7 bit 15 = bob 32	Each bit represents a SmartBob. If the bit is on then the depth data is valid.
4x0008 - 4x0010	Reserved	
4x0011	Bob 1 Measured Data	feet times 10
4x0012	Bob 2 Measured Data	feet times 10
4x0013	Bob 3 Measured Data	feet times 10
4x0014	Bob 4 Measured Data	feet times 10
4x0015	Bob 5 Measured Data	feet times 10
4x0016	Bob 6 Measured Data	feet times 10
4x0017	Bob 7 Measured Data	feet times 10
4x0018	Bob 8 Measured Data	feet times 10
4x0019	Bob 9 Measured Data	feet times 10
4x0020	Bob 10 Measured Data	feet times 10
4x0021	Bob 11 Measured Data	feet times 10
4x0022	Bob 12 Measured Data	feet times 10
4x0023	Bob 13 Measured Data	feet times 10
4x0024	Bob 14 Measured Data	feet times 10
4x0025	Bob 15 Measured Data	feet times 10
4x0026	Bob 16 Measured Data	feet times 10
4x0027	Bob 17 Measured Data	feet times 10
4x0028	Bob 18 Measured Data	feet times 10
4x0029	Bob 19 Measured Data	feet times 10
4x0030	Bob 20 Measured Data	feet times 10
4x0031	Bob 21 Measured Data	feet times 10
4x0032	Bob 22 Measured Data	feet times 10
4x0033	Bob 23 Measured Data	feet times 10
4x0034	Bob 24 Measured Data	feet times 10
4x0035	Bob 25 Measured Data	feet times 10
4x0036	Bob 26 Measured Data	feet times 10
4x0037	Bob 27 Measured Data	feet times 10
4x0038	Bob 28 Measured Data	feet times 10
4x0039	Bob 29 Measured Data	feet times 10
4x0040	Bob 30 Measured Data	feet times 10
4x0041	Bob 31 Measured Data	feet times 10
4x0042	Bob 32 Measured Data	feet times 10

Table 3-4 Tophat Input Summary Register List

Register	Measurement	Notes
3x0001	Online Status (dev 1-16) Bit 0 = bob 1, bit 15 = bob 16	Each bit represents a SmartBob. If the bit is on then the bob is online.
3x0002	Online Status (dev 17-32) Bit 0 = bob 1,7 bit 15 = bob 32	Each bit represents a SmartBob. If the bit is on then the bob is online.
3x0003	Valid Data Status (dev 1-16) Bit 0 = bob 1, bit 15 = bob 16	Each bit represents a SmartBob. If the bit is on then the depth data is valid.
3x0004	Valid Data Status (dev 17-32) Bit 0 = bob 1,7 bit 15 = bob 32	Each bit represents a SmartBob. If the bit is on then the depth data is valid.
3x0005	Bob 1 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0006	Bob 2 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0007	Bob 3 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0008	Bob 4 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0009	Bob 5 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0010	Bob 6 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0011	Bob 7 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0012	Bob 8 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0013	Bob 9 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0014	Bob 10 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0015	Bob 11 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0016	Bob 12 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0017	Bob 13 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0018	Bob 14 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0019	Bob 15 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0020	Bob 16 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0021	Bob 17 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0022	Bob 18 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0023	Bob 19 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0024	Bob 20 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0025	Bob 21 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0026	Bob 22 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0027	Bob 23 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0028	Bob 24 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0029	Bob 25 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0030	Bob 26 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0031	Bob 27 Measured Data/Meas. Status	feet times 10/Table 3-2
3x0032	Bob 28 Measured Data/Meas. Status	feet times 10/Table 3-2

Table 3-5 Tophat Output Summary Register List

Register	Measurement	Notes
4x0001	New Measurement Trigger	Write the Modbus slave address of a single bob to trigger a drop. Write any value ≥ 240 to drop on all bobs.

Example 1

Figure 4-1 shows system with a Modbus Master, a MUCM, and two SmartBobs on tanks. The Modbus RTU Master has an RS-232 port and is configured for 19200 baud, 8 data bits, 1 stop bit and NONE parity. The SmartBobs are set for slave addresses 1 and 2 and these are mapped to Modbus Slave Addresses 1 and 2 respectively.

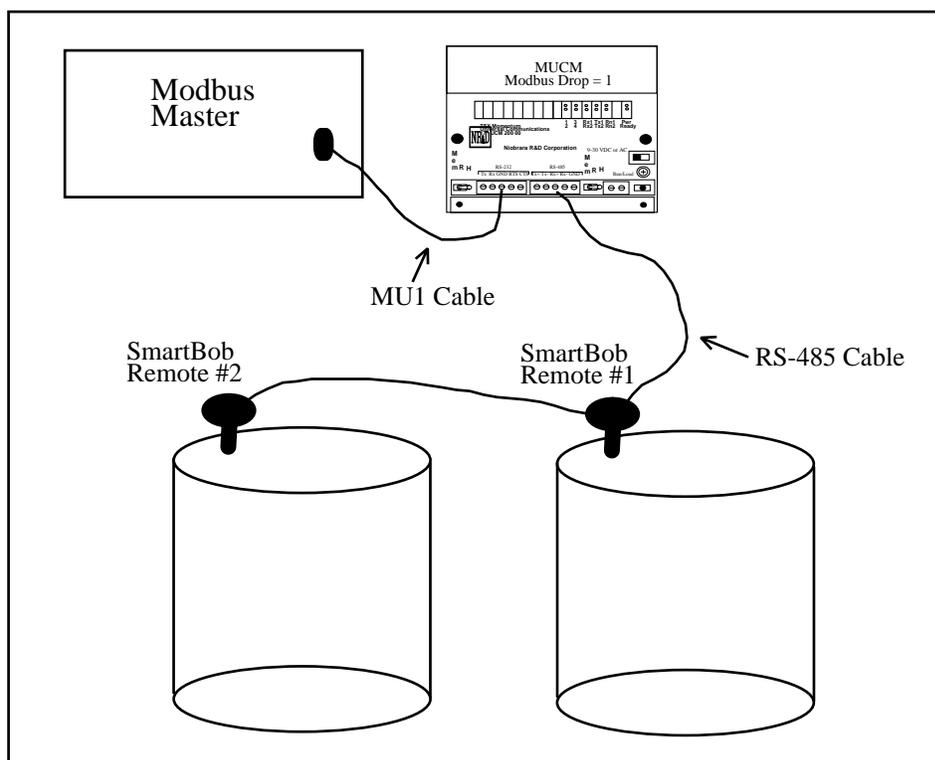


Figure 4-1 Example 1 Layout

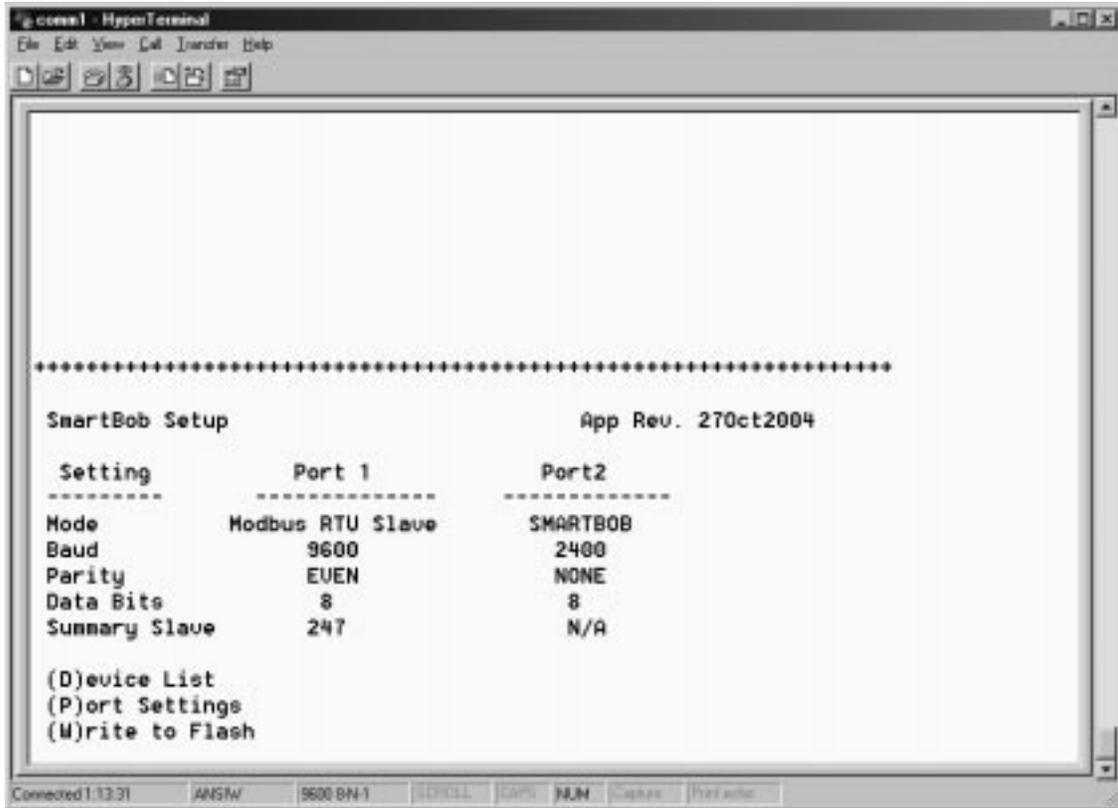


Figure 4-2 Hyperterminal Setup Main Screen



Figure 4-3 Hyperterminal Setup Device Screen

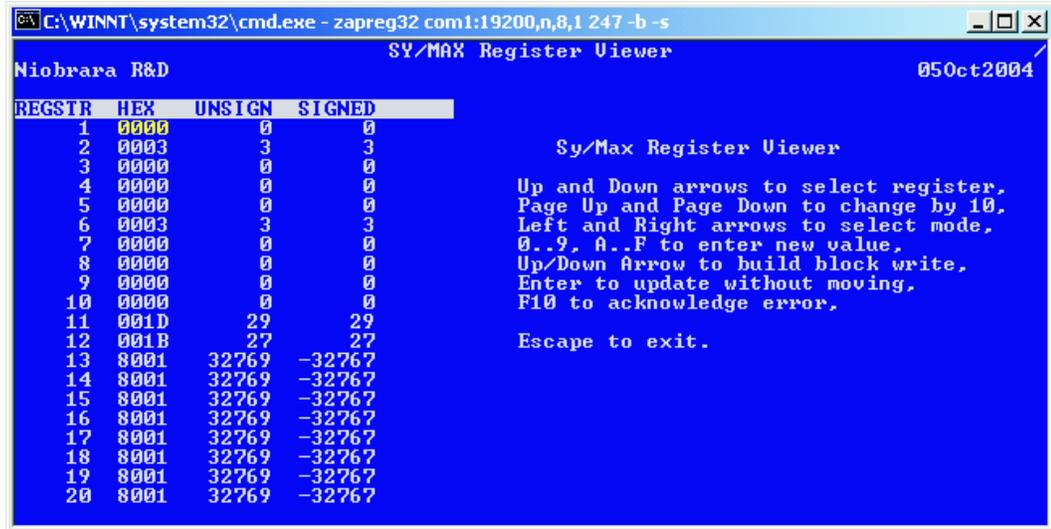


Figure 4-5 Zapreg32 of Slave 247 Screen

Testing and Troubleshooting

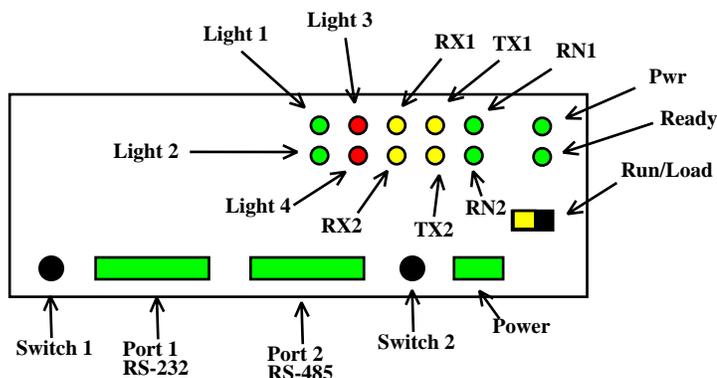


Figure 5-1 MUCM Lights and Switches

Switches

- Switch 1 controls the running of the SmartBob application.
 - Mem Prot - Not used.
 - Run - The middle position is the normal running setting for this switch. The RN1 light should be on and other lights may be on or flashing to indicate operation.
 - Halt - The right position of this switch halts the application. Move to this position when loading new versions of the application with qload.
- Switch 2 turns on the terminal server for setup.
 - Mem Prot - The far left position forces the unit to enable the configuration terminal server on the RS-232 port. The RN1 light will be on and lights 1, 2, 3, and 4 will all be on to indicate the terminal server is enabled. Connect an MU1 cable to the RS-232 port to a PC and run a terminal emulator (Hyperterminal) at 9600,N,8,1, with VT100 emulation.

- Run - Not Used.
- Halt - Not Used.
- The Run/Load switch is used for loading firmware into the MUCM with FWLOAD. Normally, this switch is in RUN but is moved to LOAD before starting the download. Light 3 is ON when the switch is in LOAD.

MUCM Lights

The MUCM has several lights to give indication of activity of the application and serial ports.

- The **Pwr** light is green and indicates that the MUCM is powered and booted.
- The **Ready** light is green and indicates that the MUCM is communicating with a tophat adapter. This light will not be on because the a tophat is not used.
- The green **RN1** light indicates that the application is running. This lights should be on when the switch 1 is in RUN or MEM PROT. If the switch is in a run position but the RN1 light is off then qload the application.
- The green **RN2** light indicates that an application 2 is running. This light should always be off in the SmartBob application.
- The yellow **Tx1** light indicates that the MUCM RS-232 port is transmitting data. This light should normally be occasionally flashing as the Modbus Master polls the MUCM.
- The yellow **Rx1** light indicates that the MUCM RS-232 port is receiving data. This light should normally be occasionally flashing as the Modbus Master polls the MUCM.
- The yellow **Tx2** light indicates that the MUCM RS-485 port is transmitting data. This light should normally be quickly flashing as the MUCM polls the SmartBobs.
- The yellow **Rx2** light indicates that the MUCM RS-485 port is receiving data. This light should normally be quickly flashing as the MUCM polls the SmartBobs.
- **Light 1** is a green light controlled by the application. Light 1 is lit every time the MUCM receives a valid Modbus message. It should be blinking every time the Modbus Master sends a query. If lights 1, 2, 3 are all on then the unit is in the configuration terminal server mode.
- **Light 2** is a green light controlled by the application. Light 2 indicates that there are SmartBobs configured to poll and that the unit is polling them. Light 2 should be on most of the time and slightly flash off. If lights 1, 2, 3 are all on then the unit is in the configuration terminal server mode.
- **Light 3** is a red light controlled by the application. Light 3 indicates an error in the Modbus Message. It will come on briefly if an attempt is made to read a bob that is offline or if there is a problem with the Modbus query. Light 3 is normally off. If lights 1, 2, 3, and 4 are all on then the unit is in the configuration terminal server mode.
- **Light 4** is a red light controlled by the application. If light 4 is normally off but comes on briefly to indicate that the MUCM did not receive a reply from the bob.

If lights 1, 2, and 3 are all on then the unit is in the configuration terminal server mode.

Testing the Modbus Connection

The program ZAPREG32.EXE may be used to quickly test the Modbus settings on the MUCM.

- 1 Connect the Niobrara MU1 cable to the MUCM port 1 and the serial port of the PC.
- 2 Open a Command Prompt. On most Windows systems do a Start, Programs, Accessories, Command Prompt.
- 3 From the command line enter the following:

```
>zapreg32 com1:9600,e,8,1 247 -b
```

where com1: is the PC's com port, 9600,e,8,1 are the settings of the MUCM's RS-485 port, 247 is a special drop number that the MUCM will respond to whether it is talking to the bobs or not, and the -b tells zapreg to use Modbus RTU.

A screen like Figure 5-2 should appear. The left column is the Holding Register number, the data is shown in the HEX, SIGNED, and UNSIGNED columns. The arrow keys and Page UP/Down may be used to move around. Values may be entered directly and the change occurs when the Enter key is pressed.

When finished verifying that the communication is good, press ESC and the program will exit.

To verify that the bob data is present, substitute the Modbus Slave address (default=1) for the 247 in the command line above. If the MUCM is talking to the bob then the data will be displayed. If the MUCM is not talking to the bob then "Read Reply Timeout" will be displayed on zapreg.

```

C:\WINNT\system32\cmd.exe - zapreg32 com1:9600,e,8,1 247 -b -s
SY/MAX Register Viewer
Niobrara R&D 050ct2004

REGSTR  HEX  UNSIGN  SIGNED
 1  0000      0      0
 2  0003      3      3
 3  0000      0      0
 4  0000      0      0
 5  0000      0      0
 6  0003      3      3
 7  0000      0      0
 8  0000      0      0
 9  0000      0      0
10  0000      0      0
11  001D     29     29
12  001B     27     27
13  8001    32769  -32767
14  8001    32769  -32767
15  8001    32769  -32767
16  8001    32769  -32767
17  8001    32769  -32767
18  8001    32769  -32767
19  8001    32769  -32767
20  8001    32769  -32767

Sy/Max Register Viewer
Up and Down arrows to select register,
Page Up and Page Down to change by 10.
Left and Right arrows to select mode,
0..9, A..F to enter new value,
Up/Down Arrow to build block write,
Enter to update without moving,
F10 to acknowledge error,
Escape to exit.

```

Figure 5-2 ZAPREG32 Screen